PAN-PACIFIC ENTOMOLOGIST
January 1982, Vol. 58, No. 1, pp. 19–24

BIOLOGY OF *EUTRETA DIANA* OSTEN SACKEN ON SAND SAGEBRUSH *ARTEMISIA FILIFOLIA* TORR. (DIPTERA: TEPHRITIDAE)

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Eutreta diana Osten Sacken is one of the most widely distributed and frequently encountered gall-forming tephritids occurring in western North America. Since its original description, *E. diana* has been reported from most western states (Foote and Blanc, 1963). In his recent treatment of the genus, Stoltzfus (1977) summarized what was known of *E. diana* biology: its seasonal occurrence, distribution and host-plant associations. Two publications have reported hymenopteran parasites reared from *E. diana* galls (Fronk et al., 1964; Furniss and Barr, 1975).

The object of this paper is to make known for the first time the occurrence of *E. diana* in Texas and its association with sand sagebrush, *Artemisia filifolia* Torr., and to assess its impact on current year growth of that plant.

Methods and Materials

During the period of May 1976 through November 1977 studies were conducted on the English Ranch, 4 miles east of Crosbyton, Crosby Co., Texas. During the seasonal occurrence of the larval, pupal and adult stages, forty galls and associated current year growth were collected at two week intervals and returned to the laboratory. Twenty galls from each collection were measured to provide an index of gall development. The galls were then dissected to monitor the occurrence and activity of various gall inhabitants. The contents of each gall was recorded and the biological role of each inhabitant assessed. The cephalopharyngeal skeletons of *E. diana* larvae were measured and their length and shape recorded. First and second instar skeletons were studied by preparing entire larvae in temporary glycerine mounts; skeletons of third instar larvae were removed from the body prior to mounting.

The remaining twenty galls from each collection were held for rearing. After rearing activities were completed the galls were oven-dried and their

weights recorded. Concurrent with gathering galls for laboratory analysis 20 uninfested terminals were gathered from the same plants. These were returned to the laboratory where their lengths were measured. A paired-T-test was used to compare dry weights of galled versus uninfested stems.

At the end of each growing season a straight line transect was laid out across a portion of the study site not utilized for gathering samples. Galls occurring on the first one hundred infested plants encountered along the transect were counted and categorized according to their relative state of decomposition: category 1, current year's galls; category 2, last season's galls, appearing brown but with leafy covering still intact; category 3, galls two years old, outer surface bare but not broken; category 4, galls three years old and older, bare and broken, generally with only lower portions of the gall remaining.

Results

Examination of the cephalopharyngeal skeleton provided the basis for determining the instar of each *E. diana* larva examined. First instar skeletons appear noticeably short with respect to their width when viewed laterally. Second and third instar skeletons are relatively long with respect to their width and are easily separated from those of the first instar. Definitive separation of all second and third instars is accomplished using the length of the longest axis, which falls within a defined range for each instar (Fig. 1).

Seasonal occurrence.—First instar larvae begin hatching during the latter half of March with hatching continuing until the middle of April. The length of the first stadium is approximately 32 days. By the end of May all larvae have attained the second instar. Third instar larvae first appear during the third week of June. By mid-July all larvae have attained the third instar. The lengths of the second and third stadia are approximately 63 and 64 days, respectively. Pupae first appear during the third week of August. By the second week of September all individuals have pupated. The length of pupation is approximately 30 days. Adult flies emerge between the third week of September and the middle of October. They remain in the field until frost.

Oviposition begins in mid-October and continues as long as adults remain active. Females deposit one egg per axillary bud. Eggs are placed lengthwise between overlapping bud scales. A female frequently deposits several eggs in the axillary buds of a single branch. As many as 17 galls of a single age class have been found on a given branch. Undisturbed adults tend to remain on the same plant. Females have been observed ovipositing on the same plant for as many as four successive days.

Gall development and distribution.—At about the same time *A. filifolia* begins to grow noticeably in March, newly hatched larvae bore through the

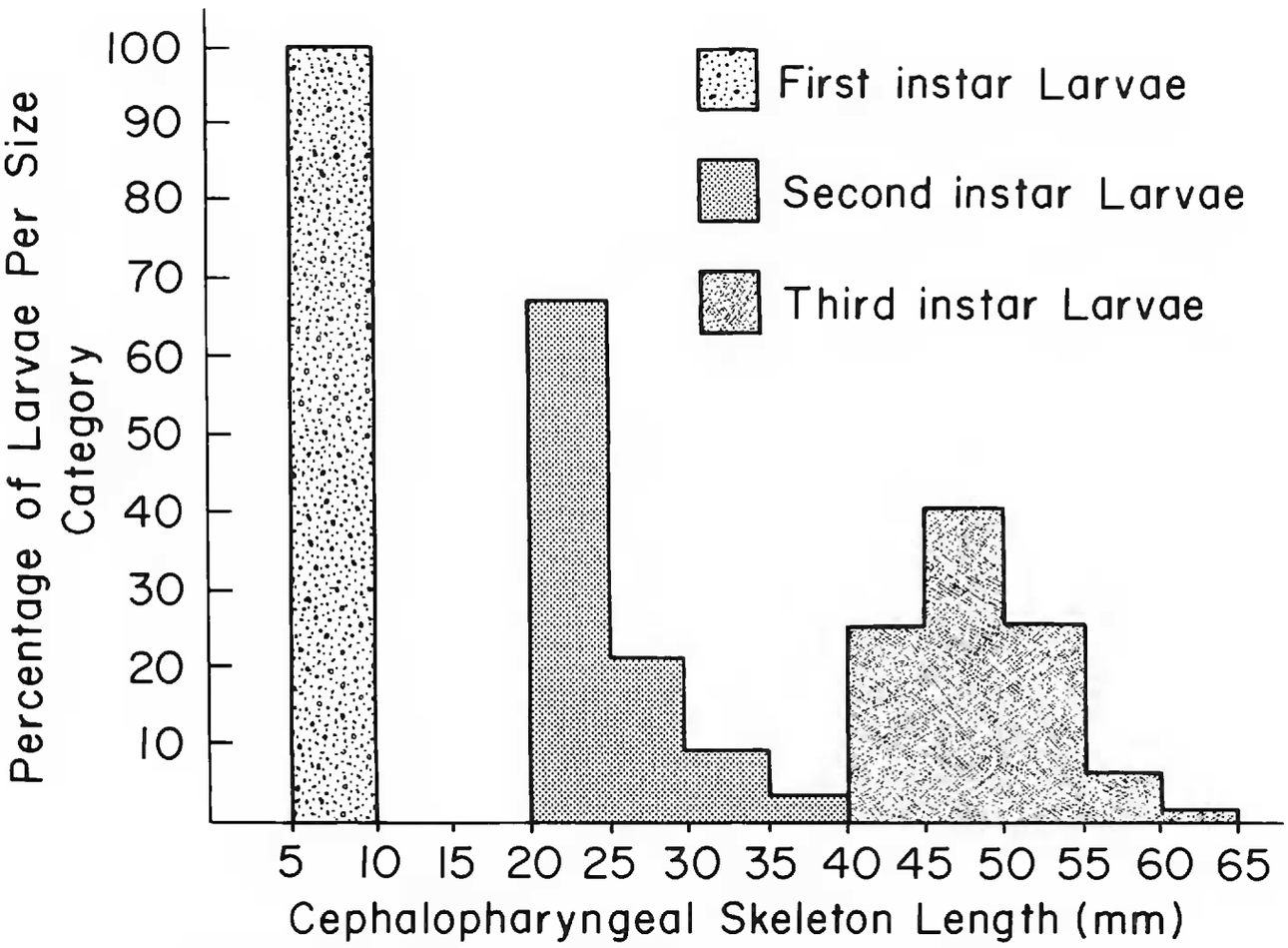

Fig. 1. Cephalopharyngeal skeleton lengths in *Eutreta diana* larvae.

base of the axillary bud and begin to feed at the base of the developing stem. First instar feeding is restricted to the center of the developing stem. Stem swelling is first noted after feeding has progressed for about two weeks. Early second instar feeding occurs in both the developing gall and adjacent stem but is eventually confined to the gall proper, a phenomenon apparently corresponding to the hardening of stem tissue. As feeding continues the gall chamber is sealed from the stem cavity by developing plant tissue and frass. Late second and third instar feeding is confined to the surface of the gall cavity. Mature third instar larvae feed in the distal portion of the gall to produce an emergence portal covered by only a thin epidermal layer.

Gall development, as reflected by gall diameter (Fig. 2), corresponds directly to larval feeding but is arrested about two weeks prior to pupation. In instances where the larva succumbs prior to the third instar, gall formation ceases.

The direct effect of *E. diana* feeding on the host plant is the interruption of internodal elongation. Both galled and normal stems increase in length until mid-July, though normal stems increase at a much faster rate (Fig. 3). Dry weights of galled and normal stems do not differ significantly at the five percent level when compared using a paired-T-test.

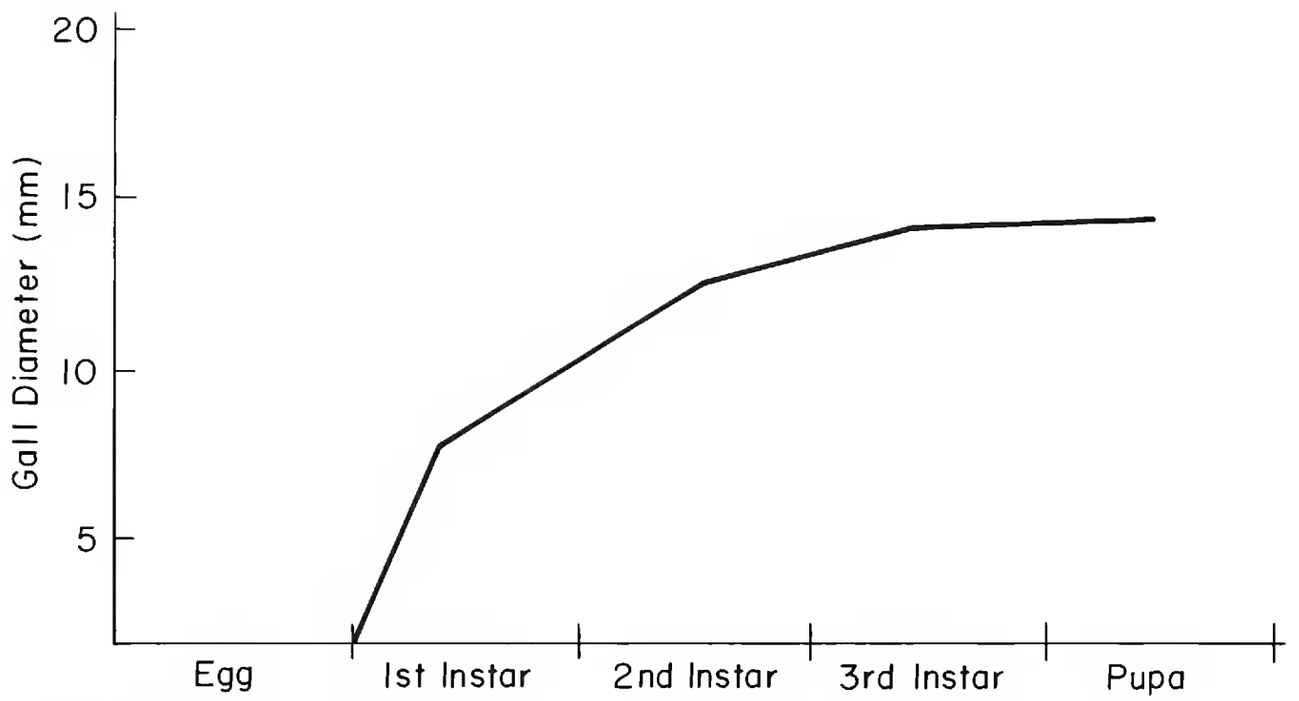

Fig. 2. Relationship of *Eutreta diana* development to gall diameter.

Plants occurring along predetermined transects were examined at the end of each growing season; galls were placed in one of four categories according to their apparent age. Galls exhibited a clumped distribution, with an average of 42 per plant (range 1–68). The average number of category 1 galls

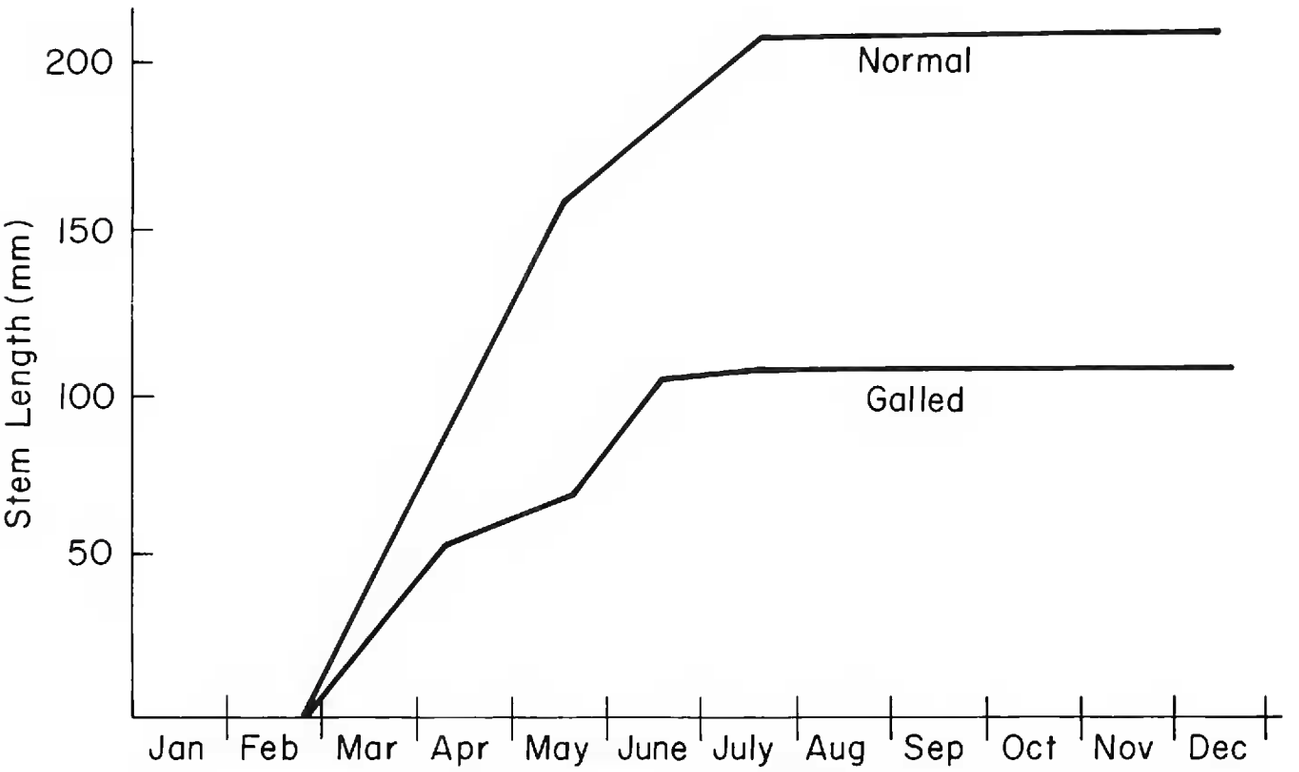

Fig. 3. Average length of galled and normal *Artemisia filifolia* stems.

found on five plants not previously infested was 9 (range 4–17), whereas the average number of category 1 galls on 81 plants exhibiting all four age classes was 24 (range 1–43). When the data from all 100 infested plants were pooled, the following averaged were obtained: category 1—21 (range 1–43); category 2—9 (range 4–12); category 3—7 (range 3–10); and category 4—5 (range 1–8) galls per plant.

Gall associates.—Six species of parasitic Hymenoptera have been associated with galls of *E. diana*. Of these, two occur commonly and are associated with larval or pupal stages. Four are uncommon and of undetermined affinity. An undetermined *Eurytoma* sp. (Eurytomidae) infested 21 percent of the *E. diana* galls reared during the study. It functioned as a solitary ectoparasitoid of second and third instar larvae. *Eurytoma* larvae that have devoured their host have been observed feeding on tissues of the gall wall. Pupation occurs within the gall cavity. Adult *Eurytoma* emerge in September.

A *Tetrastichus* sp. (Eulophidae) emerged from 24 percent of the galls held for rearing. Larvae of this species are multiple endoparasitoids of *E. diana* larvae and pupae. Their presence causes the host to succumb during pupation. Adult emergence occurs in September and October with as many as 27 individuals emanating from a single gall. *Tetrastichus* females gain access to the host larva by chewing a hole through the gall, then ovipositing directly in the host. Similar oviposital behavior has been recorded for *Tetrastichus cecidophagus* Wangberg (Wangberg, 1977).

Two undetermined species of *Eupelmus* (Eupelmidae) were reared from galls containing *E. diana* pupae. Their combined presence occurred in less than one percent of the galls examined. One female *Gastrancistrus* sp. (Pteromalidae) and one female representing an undetermined genus near *Comperilla* (Encyrtidae) were reared from galls containing *E. diana* pupae during September 1976.

Summary

Eutreta diana is reported from *Artemisia filifolia* for the first time, and its known distribution expanded to include the Texas panhandle and High Plains. The fly is univoltine and overwinters in the egg stage. Its three larval instars are separated by the shape and length of the cephalopharyngeal skeleton. Gall development is a response to feeding by first, second and early third instar larvae. Galled stems grow at a reduced rate until mid-July by which time they have reached their maximum length. Galls continue to increase in diameter until the larva stops feeding. There is no significant difference between two oven-dry weights of galled and uninfested stems. The occurrence of relatively large numbers of current season galls on pre-

viously infested plants may be explained at least in part by the sedentary behavior of undisturbed female *E. diana*.

Acknowledgments

The authors wish to thank Dr. W. Bryan Stoltzfus, Iowa State University and Dr. Carl M. Yoshimoto, Canadian Biosystematic Research Institute for the respective identifications of *E. diana* and its hymenopterous parasites. Funding for this project was provided by the College of Agriculture, Texas Tech University under whose auspices the results are published as contribution T-10-116.

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